Socio-Demographic and Nutritional Status Correlates in Pulmonary Tuberculosis Patients in Calabar, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author RIEN was responsible for project conception, design, review of literature, methodologies, acquisition, statistical analysis and interpretation of data and preparation of draft manuscript. Author GMN was responsible for review of literature, statistical analysis and interpretation of data and preparation of draft manuscript. Authors EHI and ENE were responsible for project design, coordination, methodologies and interpretation of data. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Tuberculosis (TB) continues to rank high in contributing to the global disability adjusted life years with 10 million new cases yearly worldwide. Having effective control of TB particularly in endemic communities should be predicated on understanding factors that drive its upsurge.
Objectives: This study assessed the association between socio-demographic factors and nutritional status among adults with pulmonary TB in Calabar, Nigeria.
Methods: A descriptive analysis of a randomized controlled study that enrolled 81 clinically diagnosed pulmonary TB patients that met the eligibility criteria. Data assessed were, socio-

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demographic, clinical, dietary, anthropometric, haematological and serum concentration of micronutrients. Results were presented in frequencies, percentages, tables and chart. Chi-square (Y^2) test was used to determine existence of associations between variables at 5% level, while, Pearson Correlation test was applied to determine the correlation between variables. P-value was used to determine significance of tests.

Results: Using body mass index (BMI) as a proxy of nutritional status, results indicate that 33.4% of patients were undernourished with no discernible gender differences (p=0.254). Income level classification was observed to be statistically significantly associated with undernutrition (p=0.021), with those in the low-income category most at risk. Correlation analysis of key variables indicated that low serum ascorbate, zinc and retinol were independently associated with low BMI. These associations were statistically significant (p<0.05).Singleness was identified as a risk factor for undernutrition (p=0.060). Low functional status proxied by Karnofsky score <50% tended to align more with patients in the low income level category.

Conclusion: Results consistently indicate that patients in the low income category had higher proportion of lower ranges of haemoglobin, protein parameters, serum ascorbate, zinc and retinol concentrations considered deficient. Thus, poverty alleviation strategies should be highly prioritized in TB programming for effective control.

1. INTRODUCTION

Tuberculosis (TB) continues to inflict colossal stress on the health and general well-being of individuals and households globally. An estimated 10 million new cases occur yearly making the disability adjusted life years (DALYs) attributable to TB to be very huge, with it being ranked among the top ten contributors to DALYs [1-4]. Approximately 95% of all TB cases and 98% of deaths due to TB are in the developing countries with 25% of such deaths constituting all avoidable deaths in developing countries [1,3]. Nigeria is recognized to bear the highest burden of these TB statistics in Africa [3].

Understanding factors that drive the transmission and natural history of TB in an endemic area like Nigeria is pivotal to effective control. Leads from published literatures reveal that light has been relatively shed on the clinical aspects of these factors in the management of TB [5-7], but less is known about non-clinical factors. Yet, the health conditions of individuals are essentially determined by age and circumstances, in which they live, work and grow [8-9].

TB has also been recognized to be linked to socioeconomic factors including education status, occupation, income level, distance from the nearest health unit, marital status, type of a dwelling house, household size and land ownership [1,5,10,11,12,13]. Nutrition related factors have also been known to be allied to TB [4,14,15,16,17,18]. How these factors interact and the magnitude of these interactions with TB in this setting is not well elucidated. This dearth of knowledge may be affecting our approach to TB control. Herein lies the primary rationale for this study of the correlates of socio-demographic factors and nutritional status among adults with pulmonary TB.

2. METHODOLOGY

2.1 Description of Study Population and Sample Size

This is a descriptive analysis of a micronutrient supplementation randomized controlled study. The study involved the screening of 182 patients seen at the out-patient clinic of Dr Lawrence Henshaw Memorial Hospital, Calabar, Cross River State, Nigeria. Eligibility was based on the following criteria; newly diagnosed pulmonary TB (determined by AFB sputum smear and clinical examinations), aged 18 years and above, intention of staying in the study area for at least eight weeks and provides informed consent for participation. The sample size was calculated adopting the method reported in Ejemot-Nwadiaro [19] using difference in mean formula for two independent groups. Meeting these inclusion criteria above and considering the sample size determined culminated in having 81 clinically diagnosed pulmonary tuberculosis patients who enrolled in this study. The details of the sample size calculation, sampling method, exclusion criteria are reported in [18].

2.2 Data Collection Methods

2.2.1 Qualitative data

Data on the presence of a bacilli Calmette-Guérin (BCG) scar of patients were documented. Functional impairment was assessed using the Karnofsky Performance Scale Index. It is assessed in individual patients to compare effectiveness of different therapies and for prognosis. The score ranges from 0 (dead) to 100 (normal). The lower the Karnofsky score, the lower the chances of survival for most serious illnesses [20].

2.2.2 Quantitative data

Direct microscopy was employed to assess three specimen of early morning sputum taken from each patient for examination of sputum conversion from positive to negative. We adopted the Ziehl-Nelson staining method for the number of acid fast baccili (AFB) visible in oil immersion.

A semi-structured questionnaire was used to elicit information on socio-demographic variables, nutrition knowledge and diet history of each patient. Quantity consumed was not teased from the diet history since weighed food intake will be difficult to do in an out-patient facility-based study of this nature. This tool was a face-validated 68-item questionnaire that yielded 80.3 Cronbach alpha reliability estimates. International Society for Advancement of Kinanthropometry (2001) recommended procedures and methods were adopted for measurement of nutritional anthropometric variables including; obtaining standardized records and methods for maintaining precision and accuracy of instruments. The key indicators assessed included; height measured in centimeters (cm), weight in kilogram, mid-upper arm circumference (MUAC) was measured and recorded in centimeters (cm). ADIOPOMETER[TM] Skinfold Callipers used to assess skinfold thickness (mm) of subcutaneous fat at the four sites; bicep, tricep, subscapular, and suprailliac respectively. Indices; weight-for-height (acute undernutrition – wasting), body mass index (BMI) and mid-upper arm circumference (MUAC); provide approximate reflection of nutritional status. Body mass index (BMI) was determined from the values of weight (kg) and height (m^2) for each subject. Values 18.5 – 25 Kg/m^2 are considered the normal range. Whereas, any value below 18.5 Kg/m^2 would be regarded as underweight while values above 25 Kg/m^2 would be regarded as varying degrees of overweight and obesity. Durnin and Womersley (1974) equation was employed to extrapolate the total body fat (TBF) and fat free-mass or lean body mass (LBM) from the measured skinfold thickness of each patient.

Fasting whole blood (5ml) was withdrawn from each patient by venipuncture into vaccutainers. They were protected from light and stored at – 20°C, centrifuged and later processed for analysis and estimation of serum vitamin A and ascorbic acid (Krishna and Ranjhan, 1980), zinc; using the direct colorimetric method (Homsher and Zak, 1985); serum total protein (Biuret method of Doumas*et al*., 1981), heamoglobin (Cyanmethaemoglobin technique), and albumin (Bromocresol Green method) as described in Chawla [21]. Globulin was estimated by subtracting the albumin level from the total protein. Human immunodeficiency virus (HIV) status screening test involved the qualitative detection of antibodies to HIV-1 and -2 determined by Immunochromatographic method (Arai et al. 1999).

2.3 Data Analyses

Data were entered and analysed using EPI-Info statistical software. Results were presented in frequencies, percentages, tables and chart. Chi-square (Y^2) or Fisher's exact test was used to determine existence of associations between variables at 5% level significance, while, Pearson correlation test was applied to determine the correlation between variables. P-value was used to determine significance of tests.

3. RESULTS

3.1 Socio-Demographic Description of Study Participants

Socio-demographic characteristics of the patients (Table 1) indicate that 45 (55.5%) of the total participants were males, while 36 (44.4%) were females; reflecting 11.1% difference in the number of males and females in this study. The ages of the study participants ranged from 18 to 70 years with a mean age of 33.9 ± 12.03 years (Table 2). The study participants were mostly never married - singles 41(50.6%) with those married 30 (37.0%). A total of 50 (61.7%) patients in all were singles (singleness) including one (1.2%) divorced, three (3.7%) separated and five (6.2%) patients who were widowed.

The educational level of the patients showed that 6 (7.4%) had no formal education, 31 (38.3%) completed primary education level while 26 (32.1%) attained secondary education level. Eighteen (22.2%) attained tertiary education. The study participants were engaged in a broad range of main occupation from artisans 14 (17.3%) (tailors, hairdressers, masons, mechanics, carpenters, etc.), farming, fishing to low-level cadre civil service (19.8%) with the state or federal government. Large proportions of the patients (27) were unemployed, made up of mainly students (24.7%) and housewives (8.6%) respectively. Most of the participants had household size of or lived with at least 6 – 8 persons (33.3%) sharing the same cooking pot.

The average income per month of the participants shows that 49(60.5%) majority were in the low-income (<₦18,000) category. This figure included those with no reliable source of income. Only 5 (6.2%) of the study participants were categorize as high-income (>₦72, 000). These categorizations are based on the Nigerian National minimum wage of ₦18,000 Naira per month.

Table 1. Socio-demographic characteristics of pulmonary tuberculosis patients in Calabar, Nigeria

Characteristics	Frequency (n = 81)	Percentage
Sex: Male (n)	45	55.6
Female	36	44.4
Age range (years)		
18 – 25	28	34.6
26 – 35	25	30.9
36 – 45	11	13.6
46 – 55	14	17.3
≥56	03	03.7
Marital Status:		
Single	41	50.6
Married	30	37.0
Divorced	01	01.2
Separated	03	03.7
Widow/widower	05	06.2
Cohabitation	01	01.2
Education:		
No formal education	06	07.4
Primary	31	38.3
Secondary	26	32.1
Tertiary	18	22.2
Main occupation		
Farming	05	06.2
Fishing	01	01.2
Trading	18	22.2
Student	20	24.7
Civil servant	16	19.8
Artisans	14	17.3
Others	07	08.6
Household size:		
1 - 2	21	25.9
3 - 5	25	30.9
6 - 8	27	33.3
>9	08	09.9
Income per month*		
Low income	49	60.5
Medium income	27	33.3
High income	05	06.2

* Income per month – low income: ≤ N18,000 (minimum wage); medium income: >N18,000 – N72,000 and High income: >N72,000

3.2 Other Key Characteristics of Study Participants

Table 2 indicates other characteristics describing the study participants. They had average height of 163.5 cm with standard deviation of 8.58 cm with the least height of 138 cm and the tallest being 180 cm. On the average the participants weighed 54 kg. The presence of a bacilli Calmette-Guérin (BCG) scar was observed in 37 (45.7%); indicative that they had vaccination against TB used primarily to heighten the resistance of persons to TB. However, in all more males (54.1%) had BCG vaccination than females (Table 2).

Of the 81 patients 20 (25%) had three positive smears, 28 (35%) had two positive smears and 17 (21%) had one positive smear for acid-fast bacilli (AFB). However in 16 (20%) of the patients AFB was not detected. The inability to detect AFB in sputum was not used to preclude eligibility since they all had clinical symptoms consistent with pulmonary tuberculosis as adjudged by the clinician at the time of diagnosis. This grading was based on Bronkhorst scale. A total of 21 (25.1%) patients in this study were HIV sero positive with more females (33%) than males (20%) having TB-HIV co-morbidity (Table 2).

Data on Karnofsky performance score, which assesses the patient's overall functionality, physical health judged by their level of activity shows that 15 (18.5%) had scores lower than 50% ranging from 40 = disabled; requires special care and assistance to 0 = dead. This implies that the individual requires significant amount of support akin to institutional or hospital care to carry out daily activities. It may also be indicative of rapidly progressing disease. More females (9) were observed to be in this category (Table 2).

Table 2. Other key characteristics of pulmonary tuberculosis patients in Calabar, Nigeria

Characteristics	Value/Frequency (n= 81)	Percentage
Age (years) Mean ± SD	33.9 ± 12.03	
*Range	18 - 70	
Height (cm) mean ± SD	163.5 ± 8.58	
*Range	138 – 180	
Weight (Kg) mean ± SD	54.0 ± 11.90	
*Range	32 – 95	
AFB^ Sputum Smear Grade (n)		
+ 1	17	21.0
+ 2	28	34.6
+ 3	20	24.7
Not seen	16	19.8
Functional status (Karnofsky score)		
<50%	15	18.5
≥50%	66	81.5
Presence of BCG Scar		
Yes	37	45.7
Male	20	
Female	17	
No	44	54.3
Male	24	
Female	19	
HIV Status		
Positive	21	25.9
Male	9	
Female	12	
Negative	60	74.1
Male	36	
Female	24	

* Range - minimum and maximum values observed; ^ AFB – acid-fast bacilli; BCG - Bacilli Calmette-Guérin; HIV - Human immunodeficiency virus

3.3 Knowledge and Practice of Nutrition

Almost all (97.5%) the patients reported having knowledge of the interrelationship between good nutrition (food) and health with only 2 (2.5%) study participants that did not have such knowledge (Table 3). The data on the source of the knowledge of this relationship showed that majority of the participants identified radio/television (36.7%) as the medium through which they first heard the information with News print having the least (1.3%). The information on the medium that has the greatest influence on dietary habit of the patients shows that 42% of the participants reported that radio/television is the most medium determining what, when and how often they consume foods and drinks. This is followed by hospital/clinic ranking second with 17 (21%) reporting it as the medium of this influence. Information on the number of times per day that patients eat meals (Table 3) reveals that most 74.1% reported that thrice was frequency of their meal consumption per day.

Table 4 shows the dietary pattern of patients enrolled in the study according to the frequency of consumption of food items per week classified by food groups and their derivatives. Only pooled estimates of food items in each category commonly consumed in this environment is presented. The frequency of consumption had 4 categories; food item not consumed at all, consumed once to thrice a week, consumed four to six times and consumed more than six times a week. The consumption of animal products and their derivatives by the participants was low, with 35(43.2%) reporting not consuming any of such per week.

Roots and tubers and their derivatives and cereals and their derivatives (Table 4) considered major staples in this environment. More than 70% reported consuming them at least 4 times a week. Similarly, the frequency of consumption of legumes and nuts and their derivatives such as beans, soya beans and "Moi moi" a derivative of beans, supply chiefly protein to the body were however, most (>75%) participants reported that they do not consume or consumed food items listed in this food group a maximum of three times a week. Consumption of foods classified under seeds and oils and fats and their derivatives, showed majority (63%) of the participants reported consuming less frequently or not consumed at all foods in this category; while food items classified under vegetables food group were less frequently consumed or not consumed at all by most (54.4%) of the participants. Fruits consumption pattern of patients in this study shows that about 88.9% reported not consuming at all or consumed fruits listed in this category not more than three times a week.

3.4 Links of Nutritional Status and Socio-Demographic Factors in Study Participants

Of the 81 study participants 27 (33.4%) showed features of undernutrition as they had body mass index (BMI) of less than 18.5 kg/m^2 indicative of varying degrees of underweight (Fig. 1). Of this, 11.1% had mild (17.5 kg/m^2 - <18.5 kg/m^2), 6.2% (16.5 kg/m^2 - <17.5 kg/m^2) moderate and 16.1% severe (<16.5 kg/m^2) undernutrition respectively. There was preponderance of females (38.9%) that were undernourished than males (28.9%) (Table 5). In addition, more than half (59.3%) of the study participants had normal BMI (18.5 kg/m^2 – 25.0 kg/m^2), while 6 (7.4%) were overweight to obese status (>25.0 kg/m^2).

When the 3 categories of BMI (underweight, normal and overweight), used in this study to primarily determine nutritional status were compared to key socio-demographic variables (Table 5). Gender was not statistically significant to BMI (Y^2 (2, N = 81) = 2.74, p = .25). Similarly, age (p = 0.57), education (p = 0.87), household size (p = 0.92) respectively were not significantly associated with BMI. However, marital status had a borderline significant association with BMI (Y^2 (2, N = 81) = 5.60, p = .06); while only income level was clearly statistically significant association with BMI (Y^2 (4, N = 81) = 11.5, p<.021).

Table 6 represents the proportions of study participants in the 3 categories of income levels with plasma concentrations of blood parameters indicating some aspects of nutritional status considered deficient. There were consistently higher proportions of study participants in the low income level category that had deficient concentrations of the blood parameters studied. However, haemoglobin was the variable with the highest proportion (51%) of participants in that income category, followed by serum albumin (18.5%), serum total protein (13.6%) and globulin (9.9%) respectively.

The functional status of the study participants using Karnofsky performance score as proxy (Table 7) when compared with the 3 income level category showed that most 11 (13.6%) classified as having low functional status Karnofsky score

<50 (disabled; requires special care and assistance to 0 = dead) were more in the low income level. Some select micronutrient (vitamins A and C and Zinc) serum concentrations related to the overall objective of the larger supplementation trial were compared with income level of study participants (Table 7). Seventeen (21%) out of 26 study participants that had serum retinol concentrations considered deficient (<30 μg/dl) were in the low income group. Similarly, majority (21%) of the participants with deficient concentration (<10.7 μmol/L) of serum zinc were also in the low income group. So also did participants in the low income category had higher proportion (14.8%) with serum ascrobate concentration considered deficient (<0.4 mg/dl) than the 2 other income categories.

3.5 Associations of Factors in Study Participants to Key Nutritional Status Indicators

The relationships between some selected variables are shown in Table 8. Low serum zinc (<10.7 μmol/L), retinol (< 30 μg/dl) and ascorbate (< 0.4 mg/dl) were independently associated with low body mass index (BMI). These associations were statistically significant (p<0.05). The association between BMI and deficient level of serum zinc ($r^2 = 0.23$) appeared to be stronger than that of serum retinol ($r^2 = 0.18$) and ascorbate ($r^2 = 0.05$). These are indicative that 23%, 18% and 5% of the variance in serum zinc, retinol and ascorbate concentrations respectively are explainable by the BMI.

Likewise, lower serum retinol, ascorbate and zinc levels were independently associated with lower lean body mass (LBM), total body fat (TBF) and Mid-upper arm circumference (MUAC). All were statistically significant (p < 0.05) except for the association between serum ascorbate level and LBM (p = 0.1053). The association between serum retinol levels and MUAC in which 29% of the variance in serum retinol is explainable by the variance in MUAC was observed to be the strongest.

Inverse relationships between serum retinol and zinc levels and sputum smear for acid fast bacilli (AFB) (p < 0.05). No independent association was observed between serum ascorbate and AFB (r = 0.000). Inverse relationships were also observed for the blood parameters and AFB. Except for albumin (p = 0.214) and haemoglobin (p = 0.182), these associations were found to be significant (p < 0.05). Thirteen percent variance (strongest) in globulin tended to explain the variance in AFB (Table 8).

Table 3. Knowledge and practice of nutrition by pulmonary tuberculosis patients in Calabar

Characteristics	Frequency (n= 81)	Percentage
Knowledge of importance of good food to health		
Yes	79	97.5
No	02	02.5
Source of information on the knowledge (Medium)		
Radio/TV	29	35.8
Newsprint	01	01.2
Hospital/clinic	25	30.9
School	26	32.1
Relative	09	11.1
Others	00	00.0
Medium with greatest influence on dietary pattern / habit		
Radio/TV	34	42.0
Newsprint	04	04.9
Hospital/clinic	17	21.0
School	15	18.5
Relative	18	22.2
Others	01	01.2
Frequency of meal consumption per day		
Once	02	02.5
Twice	18	22.2
Thrice	60	74.1
More than thrice	01	01.2

Table 4. Frequency of food consumption pattern using TB patients reported diet history

Food Group*^	Frequency (n = 81)			
	Not consumed	Consumed (Frequency per week)		
	0	1 – 3	4 – 6	>6
Animal foods/derivatives	35 (43.2)	32 (39.5)	10 (12.4)	4 (4.9)
Roots and Tubers	7 (8.6)	15 (18.5)	32 (39.5)	27 (33.3)
Cereals/derivatives	1 (1.2)	28 (34.6)	35 (43.2)	17 (21.0)
Fats and oils	26 (32.1)	25 (30.9)	20 (24.7)	10 (12.4)
Legumes and Nuts/derivatives	25 (30.9)	39 (48.2)	15 (18.5)	2 (2.5)
Vegetables	16 (19.8)	28 (34.6)	24 (29.6)	13 (16.1)
Fruits	34 (42.0)	38 (46.9)	8 (9.9)	1 (1.2)

Pooled estimates of food items in each category commonly consumed in this environment; ^It is assumed that nutrients totally absorbed irrespective of other underlying factors
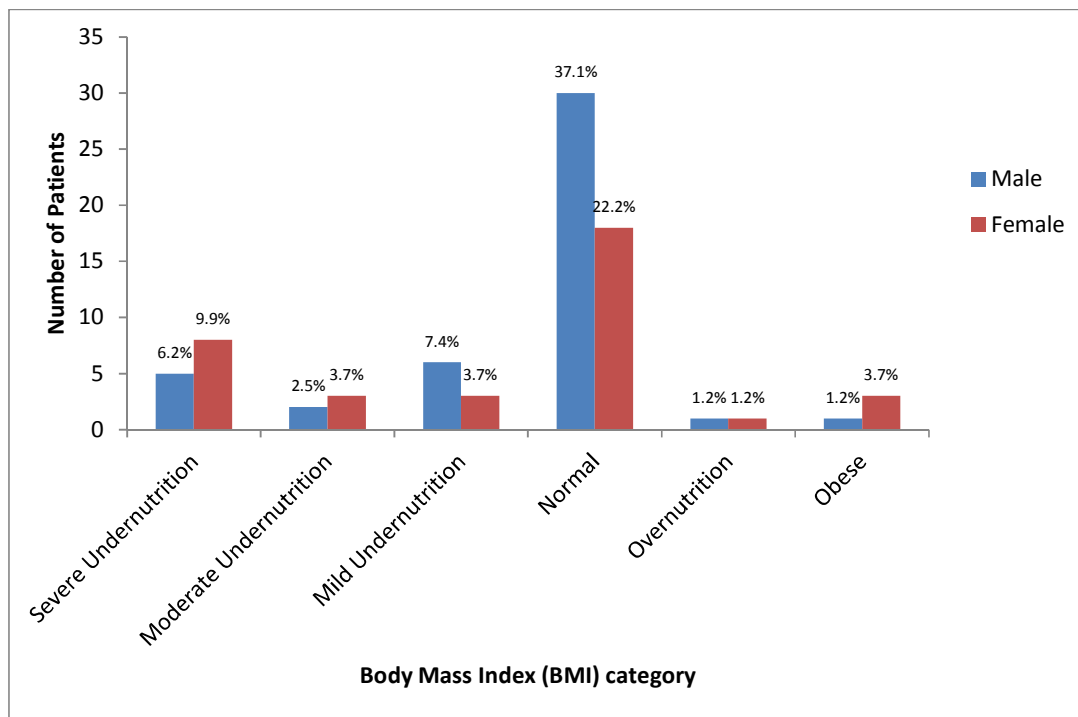

Fig. 1. Nutritional status of patients using body mass index categorization

4. DISCUSSION

The findings of this study show that 33% of the patients were undernourished as indicated by body mass index (BMI); a key nutritional status measurement used in this study. This is also in consonance with studies that reported wasting in TB [3,14,22,23,24]. With Gupta et al [14], reporting that individuals that were in the lowest (severe) BMI category had five times higher relative risk of TB than those in the highest BMI category. Consequentially, individuals with low anthropometric indices not only show features of malnutrition, but also have propensity for increased disease and death [4,23,24,25]. The percentage of undernourishment observed in this study was for most part far less than those reported by Pakasi et al [13] in Timor and Rote Island, Indonesia; 87%; Shetty et al, [24] in Bangalore, India; 72.9%, Guadie and Assamniew [26], in Adama Town, Ethiopia; 53%, Dargie et al [27] in Addis Ababa, Ethiopia 39.7% and Ebuehi et al [28] in Lagos, Nigeria was 35% respectively. These differences may be due to diverse settings of the studies, age of the patients and TB treatment status of patients. In our study, only adults' ≥18 years and assessments were before the commencement of TB treatment, whereas in some of the studies mentioned above these were not the cases.

Table 5. Key socio-demographic parameters cross-tabulated with body mass index category

Variables	Underweight (Low BMI) ($<18.5 kgm^{-2}$)	Normal (≥18.5 – $25 kgm^{-2}$)	Overweight/Obese (High BMI) ($>25 kgm^{-2}$)	Chi-square Statistics	P-value
Sex:				2.7375	0.2544
Male	13	30	2		
Female	14	18	4		
Age range (years):				6.6766	0.5719
18 – 25	10	17	1		
26 – 35	9	15	1		
36 – 45	2	7	2		
46 – 55	5	8	1		
≥56	1	1	1		
Education:				2.5102	0.867
No formal education	1	4	1		
Primary	11	18	2		
Secondary	10	15	1		
Tertiary	5	11	2		
Marital Status				5.6014	0.0608
Singleness*	21	27	2		
Married	6	21	4		
Income level				11.5	0.021
Low	20	26	3		
Medium	6	20	1		
High	1	2	2		
Household size				2.0448	0.9155
1 - 2	7	12	2		
3 – 5	10	14	1		
6 – 8	7	18	2		
≥ 9	3	4	1		

Singleness includes; never married, widowed, divorced and separated

Table 6. Concentrations of haemoglobin and protein parameters crosstab with income level category of study participants

Haematological variables□	Income level category (n)*			Total
	Low	Middle	High	
Serum Albumin:				
Deficient (<3.2 g/dl)	15 (18.5)	02 (2.5)	00 (0.0)	17 (21.0)
Adequate	34 (42.0)	25 (30.9)	05 (6.2)	64 (79.0)
Serum Total Protein:				
Deficient (<6.0 g/dl)	11 (13.6)	05 (6.2)	01 (1.2)	17 (21.0)
Adequate	38 (46.9)	22 (27.2)	04 (4.9)	64 (79.0)
Globulin:				
Deficient (<2.3 g/dl)	08 (9.9)	02 (2.5)	03 (3.7)	13 (16.1)
Adequate	41 (50.6)	25 (30.9)	02 (2.5)	68 (83.9)
Haemoglobin (g/dl):				
#Deficient	42 (51.9)	18 (22.2)	02 (2.5)	62 (76.5)
Adequate	07 (8.6)	09 (11.1)	03 (3.7)	19 (23.5)

Sub-totals only;#Pooled figures for deficient levels for male (<13 g/dl) and female (<12 g/dl); □Adequate levels above or equal to indicated figures considered deficient; Figures in parenthesis are percentages

Wasting in TB patients may have stemmed from deficiencies of protein, micronutrients and low concentrations of haematological and blood parameters [4,18,22,23]. The correlation of low concentration of these parameters with low nutritional status, lays credence to reports that these negatively impact the immune systems leaving the host predispose to intracellular

infection affecting the TB history even leading to death [28-29]. Gupta et al [14] in agreement reported that serum albumin concentration was observed to be lower in TB patients than in controls. Equally, hypoalbuminemia has been reported to influence anti-TB chemotherapy by its reduction in bactericidal activities of TB drugs; with serum albumin and haemoglobin concentrations observed as strong predictors of survival in adults with pulmonary tuberculosis [14].

Findings from this study are suggestive that Recommended Dietary Allowance (RDA) of essential nutrients are grossly unmet, strengthening the path to body's nutrient depletion, biochemical and clinical lesions particularly in tissues and organs that require these nutrients for their optimal functioning [2,18,25,29,30,31]. This may have contributed to the undernutrition observed in this study. It is however unclear whether inadequate dietary intake [2,4,25], or drug-nutrient interaction [7,16], or the increased micronutrient requirement occasioned in part by the mycobacterium also requiring these micronutrients for their multiplication [15,29,32] or the disease process [7,22,23,33] that is responsible for the characteristics low nutritional status observed in these TB patients.

The wasting and deficient levels of haematological and micronutrients in this study were observed to be dominant in patients categorized as low income group and was statistically significantly associated (p = 0.021) with poor income status. This is consistent with study of Attah et al. [17] of poor socioeconomic status being a TB risk factor (p = 0.030). Contrary to these findings, Dargie et al. [27] did not observe association of undernutrition and low income level. However, the evidence in this study that 61% of the patients were classified as low-income earners, lays credence to the point that higher economic burden of TB disease are observed in the poor as they have little disposable income due to the nature of their livelihood activities [1,5,9,10,12,13,34,35]. In addition, the average of 6-member households observed in this study is suggestive of increased demand on the already little disposable income since sustaining a family of that size on a monthly income of ₦18, 000 ($50) indicates conditions of extreme poverty. This thus exacerbates the risk of TB disease in a cumulative manner both through financial incapability to access health care services and overcrowding [17], though this study was not designed to assess cost of accessing TB treatment nor housing conditions of the patients. Implicit also in this, is the high percentage of patients in this study who had attained no more than secondary school education. As this may in part be the reason for the unemployment or not having reliable source of income [9]. Education is also recognized to influence the choice and quality of diet with concomitant effect on nutritional status [17,26,31,36]. Furthermore, studies have shown inverse relationship between level of education and TB infection [10,11,12, 13,14,24].

Table 7. Status of key parameters crosstab with income level category of study participants

Variables	Income level category (n)*			Total
	Low	Middle	High	
Serum Retinol:				
Deficient (< 30 µg/dl)	17 (21.0)	07 (8.6)	02 (2.5)	26 (32.1)
Adequate	32 (39.5)	20 (24.7)	03 (3.7)	55 (67.9)
Serum Ascorbate:				
Deficient (< 0.4 mg/dl)	12 (14.8)	04 (4.9)	00 (0.0)	16 (19.8)
Adequate	37 (45.7)	23 (28.4)	05 (6.2)	65 (80.2)
Serum Zinc:				
Deficient (< 10.7 µmol/L)	17 (21.0)	04 (4.9)	01 (1.2)	22 (27.2)
Adequate	32 (39.5)	23 (28.4)	04 (4.9)	59 (72.8)
Karnofsky score				
<50% (Low)	11 (13.6)	03 (3.7)	01 (1.2)	15 (18.5)
≥50%	38 (46.9)	24 (29.6)	04 (4.9)	66 (81.5)

Sub-totals only; ☐Adequate levels; above or equal to indicated figures considered deficient; Figures in parenthesis are percentages

Table 8. Correlation between variables in pulmonary tuberculosis patients

Variables	Co-efficient (r)	Co-efficient (r^2)	*P*-value
Retinol vs BMI	0.48	0.23	0.0000
Ascorbate vs BMI	0.22	0.05	0.0390
Zinc vs BMI	0.42	0.18	0.0001
Retinol vs AFB	-0.17	-0.03	0.042
Ascorbate vs AFB	0.00	0.00	0.7000
Zinc vs AFB	-0.14	-0.02	0.0211
Hb vs AFB	-0.17	0.03	0.182
Albumin vs AFB	-0.22	-0.05	0.214
Protein vs AFB	-0.20	-0.04	0.041
Globulins vs AFB	-0.36	-0.13	0.005
Karnofsky vs AFB	-0.17	-0.03	0.337
Retinol vs LBM	0.28	0.08	0.0101
Ascorbate vs LBM	0.17	0.03	0.1053
Zinc vs LBM	0.30	0.09	0.0077
Retinol vs TBF	0.51	0.26	0.00002
Ascorbate vs TBF	0.43	0.19	0.000053
Zinc vs TBF	0.42	0.18	0.0001
Retinol vs MUAC	0.54	0.29	0.00000
Ascorbate vs MUAC	0.42	0.18	0.00009
Zinc vs MUAC	0.52	0.27	0.000001

AFB: Acid fast bacilli (sputum smear for AFB); BMI: Body mass index; Hb: Haemoglobin; LBM: Lean body mass; MUAC: Mid-upper arm circumference; TBF: Total body fat (fat mass)

This dysfunctional dynamics of poor nutritional status, poverty and TB reflect also in physical functionality and plays into poor prognosis and survival rates of TB patients [11,13,18,27]. In line with the above, the significant proportion of patients in this study that had Karnofsky performance score of >50% indicate that they need substantial assistance for everyday living [20]. This thus implies huge dependency that reinforces poverty. This is in agreement with the findings of Dargie et al. [27] that observed higher functional impairment and that this was independently associated with undernutrition.

The preponderance of males than females in this study is consistent with the studies that reported higher incidence of males and/or identified male sex as a risk factor for TB [6,12,24,35]. It has been suggested that this difference may be due to behavioural, socio-economic [10,34] or biological or underlying epidemiological differences [3,11,24] or due to inequities in access to health care, making women less likely than men to get tested and treated for TB [6-7]. It is unclear however in this study, which of these factors is contributing most to these statistics. However, when the BMI of patients were compared to gender, there was no discernable direction of association with any of the genders (p = 0.254). This finding is in consonance with

Dargie et al. [27], that sex was not associated with undernutrition. However, contrary to these above, Guadie and Assaminew [26] reported that females were six times more likely than males to be undernourished and that association was statistically significant.

The observation that in this study, patients that were between 18 – 35 years constituted the majority supports findings of studies that, TB affects young adult population and that 75% of TB cases are found in the economically productive age group of 15-50 years [3,24,32]. However, age was observed not to be associated with BMI (p = 0.5719) in this study, so also in [24,26,27]. However, observation of this no association warrants further study.

Significant association between singleness and TB infection have been indicated [8,12,37,38]. The observation of this study is consistent with the statement above; as higher proportion of TB was seen among singles. A possible explanation for this finding is that in general, singles are less likely to engage in positive health behaviours than the married. Also given that TB is a disease of enormous social stigmatization; single persons with this disease may not easily get married making the likelihood of an individual diagnosed with TB less than likely to be married [38-39].

Conversely, Ikeda et al. [38] in their study observed that little percentage difference exist between singles (16%) and married (11%) subjects with history of TB. However, in this study BMI was observed to be independent of marital status.

5. CONCLUSION

The results of this study consistently indicate that patients in the low income category had higher proportion of lower ranges of haemoglobin, protein parameters, serum ascorbate, zinc and retinol concentrations considered deficient than the other two income level categories. Thus, poverty alleviation strategies should be highly prioritized in TB programming for effective control

CONSENT AND ETHICAL APPROVAL

Ethical clearance for the conduct of this study was provided by the Research Ethics Committee, Ministry of Health, Cross River State, Nigeria. The participants only agreed to be part of the study after they read and fully understood the objectives of the study as contained in the study information sheet. Confidentiality and anonymity of data collected were assured. Each participant subsequently provided written informed consent for participation in the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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